CONTRIBUTIONS FROM WALKER MUSEUM. I.

THE VERTEBRATES FROM THE PERMIAN BONE BED OF VERMILION COUNTY, ILLINOIS.

THE material described and figured in the present contribution comprises a portion of the vertebrate material of the Gurley Collection of Fossils in the Walker Museum, at the University of Chicago. The material is of extreme interest from both an historical and a scientific standpoint, its discovery being the first evidence of the occurrence of Permian reptiles in North America. A few isolated bones were submitted to Professor Cope, and with his usual keen insight he recognized their character and their value, and by his interest he stimulated the work of their careful collection and preservation. To Mr. Gurley is due the credit for a careful and exhaustive exploration of the "bone bed," and the preservation of the material.

Many of the forms were described by Cope in the files of the Proceedings of the Philadelphia Academy of Natural Science, and the American Philosophical Society, but only a few illustrations of the intercentra of *Cricotus* have ever been published. It was his intention to publish full descriptions of the forms, with illustrations, and for this purpose plates had been prepared for an article in one of the government publications, which was never issued. Much of the material is fragmentary, and nearly all the bones were found isolated, so that it is especially difficult to identify the species from the descriptions alone. Especially is this true when the specimens to be compared come from another locality.

In the present paper the original descriptions have been reproduced, wherever they would serve the purpose, along with some additional notes, and the specimens figured. In many instances the figures have been copied from those prepared by Cope for his unpublished work. A few of the specimens

described by Cope are now missing from the collection, and so cannot be figured.

Several specimens are preserved in the collection which were never described by Cope. I have refrained from giving new names to these, as it is altogether probable that the seemingly new forms are but portions of the skeleton of animals that have been named from other parts of the skeleton. The numbers given at the close of each description, are the record numbers of the Paleontological collection in Walker Museum, at the University of Chicago.

Janassa strigilina Cope. Plate I, Figs. 1*a*, 1*b*, 1*c*.

Strigilina linguæformis Cope, 1877, Proc. Am. Phil. Soc., p. 53. (Specific name preoccupied in 1868 by Atthey.)

Janassa strigilina Cope, 1881, Am. Nat., p. 163.

Janassa strigilina Woodward, 1889, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 38.

Generic characters: "The tooth is a flat, osseous plate, whose outline is pyriform, the wider end recurved in one direction as the transverse cutting edge; the other extremity narrowed and recurved in the opposite direction as the root. The side from which the cutting edge arises is crossed by numerous plicæ from the base of the root to near the base of the cutting edge; the opposite side is smooth."

Specific characters: "The plicate surface terminates behind in a median angle, at the base of the root. There are eight plicæ which all cross the plane, excepting the sixth, which is interrupted in the middle by the strong angulation of the seventh, which touches the fifth. The lateral extremities of the right are in contact with the base of the recurved cutting portion. The latter is convex transversely, leaving a smooth surface between it and the eighth plica. The smooth side of the tooth is shining, and there is a shallow fold, which passes around its side and crosses just at the base of the recurved cutting lamina."

MEASUREMENTS.

"Total length of the plane	.008	m
Width at base of the cutting lamina	.006	
Width at the base of the root	.004	
Thickness of plane portion	.0015	"

[No. 6500.]

Janassa gurleyana Cope. Plate I, Figs. 2*a*, 2*b*, 2*c*.

Strigilina gurleiana Cope, 1877, Proc. Am. Phil. Soc., p. 191. (Pal. Bull., No. 26.)

Janassa gurleiana Cope, 1881, Am. Nat., p. 163.

Janassa gurleiana Woodward, 1889, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 39.

"The tooth is quite small, its length only equaling the width of the known tooth of *S.* (*Janassa*) *linguæformis*. It is also narrower in proportion to the length. The root and the cutting edge are turned in opposite directions as in the other species. The principal difference between the two is seen in the character of the transverse ridges or crests of the oval face. There are two crests less, or five, with a delicate basal fold, making six, while, counting the fold, there are eight in *S.* (*Janassa*) *linguæformis*. The anterior ridge is transverse; the others slightly convex backwards, and all are equidistant and uninterrupted, which is not the case in the older species. They are also of different form, being distinct ridges with anterior and posterior faces similar. In *S.* (*Janassa*) *linguæformis* the anterior face only is vertical, the posterior descending very gradually, the whole forming a series of steps.

"Length of the ridged face, .0060^{m}; width anteriorly, .0035^{m}; width posteriorly, .0020^{m}."

[No. 6501.]

Pleuracanthus (Orthacanthus) quadriseriatus Cope. Plate I, Figs, 3*a*, 3*b*.

Orthacanthus quadriseriatus Cope, 1877, Proc. Am. Phil. Soc., p. 192. (Pal. Bull., No. 26.)

Pleuracanthus quadriseriatus Woodward, 1889, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 9.

Represented in the collection by imperfect radial spines. Both Newberry and Cope remark that it is very likely that the spines called *Orthacanthus* may belong to the the same fish as the teeth called *Didymodus* (*Diplodus*), and as the teeth are distinctly referable to the genus *Pleuracanthus Ag.*, it is perhaps best to follow Zittel in regarding all three names as synonyms of *Pleuracanthus*. The teeth and spines are found in close connection. The species here described differs from the *O. gracilis* of Newberry in having the denticles shorter. The description given by Cope is as follows: "The spine is wider than deep, and the series of denticles are widely separated. The surface between them is gently convex and smooth. The anterior face is strongly convex, and presents at each side two shallow furrows. The external groove is divided by a series of thin longitudinal denticles which are smaller than those of the principal row, and which are

sometimes confluent at the base. The principal denticles are closely placed, stout, acute, and recurved.

"Transverse diameter of shaft .0035^{m}; antero-posterior diameter .0025^{m}; the portion of the shaft preserved is straight."

It is noticeable that the denticles of the outer row become confluent in a low ridge on the lower portion of the spine.

[No. 6502.]

Pleuracanthus (Orthacanthus) gracilis Newb. Plate I, Fig. 4.

Orthacanthus gracilis Newb., Geol. Surv. Ohio, Pal., Vol. II, p. 56. Plate LIX, Fig. 7.

Orthacanthus gracilis Newb., Cope, 1881, Am. Nat., p. 163.

"Spine small and straight, about three inches long, very slender and acute; section circular at base, posterior face and sides flattened above, the angle inclosed by them set with acute, recurved, compressed denticles throughout the upper two thirds of the entire length; surface smooth or finely striate longitudinally."

The name *Orthacanthus* was used by Newberry only provisionally for spines which were supposed to belong with teeth called *Diplodus*, and was to be suppressed when the two should be found together.

It is noticeable that the denticles are fewer and larger than those on the spine of *P. quadriseriatus*, and that there is but a single row of denticles on each side.

[No. 6503.]

Pleuracanthus (Didymodus) compressus Newb. Plate I, Figs. 5*a*, 5*b*, 5*c*, 5*d*.

Diplodus (?) *compressus* Newb., Cope, 1877, Proc. Am. Phil. Soc., p. 54.

Didymodus (?) *compressus* Newb., Cope, 1883, Proc. Phil. Acad. Nat. Sc., p. 108.

Represented in the collection by several imperfect teeth. Cope offered no additional description of the form, contenting himself with the statement that "one with a lateral and median denticles nearly complete, agrees pretty well with the species cited." In 1883 he substituted the name *Didymodus*, as the name *Diplodus* was preoccupied, having been used by Rafinesque for a genus of fishes.

The teeth are much smaller than the species of the same genus found in Texas.

Later several complete crania of the genus were obtained from Texas and described in detail by Professor Cope, Trans. Am. Phil. Soc., 1884, pp. 572–590, 1 plate (Pal. Bull., No. 38). In the American Naturalist of the same year, p. 413, the genus was made the type form of the new order *Ichthyotomi* of the *Elasmobranchii*.

The form is now quite usually recognized as belonging to the genus *Pleuracanthus* Ag., one of the common forms of the Carboniferous and Permian faunas of Europe and America.

[No. 6504.]

Thoracodus emydinus Cope.

Thoracodus emydinus Cope, 1883, Proc. Acad. Nat. Sc., Phil., p. 108.

Thoracodus emydinus Woodward 1889, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 39.

"The form of the tooth or jaw on which this genus is proposed, reminds one of that of a *Diodon*, and also of one half of that of a *Janassa*. It appears to be the half of a bilateral plate, which is divided on the middle line by suture. Its form is somewhat that of the anterior part of an episternal bone of a tortoise. It consists essentially of a smooth border, separated from the remainder of the tooth by a transverse groove. The interior portion is, on the superior face (if the piece belong to the inferior jaw, and *vice versa*), transversely ridged and grooved, after the manner of the genus *Janassa*."

Specific characters: "The smooth border is wide above and below. Its edge is produced into a median projection, which is decurved. On the inferior surface it is marked by shallow grooves, which radiate from the groove which bounds it posteriorly, extending nearly to the free edge. Posterior to the bounding groove, the surface is smooth. The posterior surface above has its grooves concentric with the curved free margin. The ridges are narrow, and step-like in position, presenting their free edges backwards. There are no grooves other than these steps. They have an angular curve opposite to the angle of the free margin, and at the angle the groove which separates them is narrowed, while it widens at other points. Free edge of border thickened; surface everywhere smooth."

MEASUREMENTS.

"Length of fragment transversely	.014^{m}
Length of fragment antero-posteriorly	.011
Width of border area at median suture	.005
Seven cross ridges	.005
Thickness at suture at cross ridges	.002 "

[This specimen is missing from the collection.]

Sagenodus vinslovii Cope. Plate I, Figs. 6*a*, 6*b*.

Ceratodus vinslovii Cope, 1875, Proc. Phil. Acad. Nat. Sc., p. 410.

Ceratodus vinslovii Cope, 1877, Proc. Am. Phil. Soc., p. 54.

Ptyonodus vinslovii Cope, 1877, Proc. Am. Phil. Soc., p. 192. (Pal. Bull., No. 26.)

Sagenodus vinslovii Woodward, 1891, Cat. Foss. Fishes Brit. Mus., Pt. II, p. 262.

Sagenodus vinslovii Williston, 1899, Kans., Univ. Quart., Series A, p. 176.

"The crown of the tooth is in general outline an oval, wider at one end than the other, the inner border gently convex and entire. The outer border is marked by six shallow notches which are separated by as many sharp, compressed projections. The emarginations and denticles are the termini of corresponding grooves and ridges, which radiate from a smooth space along the inner margin of the crown. From this plane the grooves gradually deepen to the margin; the separating ridges are acute and without irregularity or serration. The base or root of the tooth is quite wide. Externally it extends beyond the border of the crown at the notches, and has projections corresponding to the denticles, from which it is separated by a horizontal notch. On the inner side the base extends like a shelf beyond the posterior half of the crown, and is produced backwards beyond its posterior border. The inferior plane is concave in transverse section; the crown is plane in all directions."

MEASUREMENTS.

"Length of crown preserved	.021[m]
Width crown	.013
Length of root preserved	.022
Depth of root internally	.005
Depth of root externally	.003 "

"This *Ceratodus* (*Ptyonodus*) resembles the species described by Agassiz under the name of *C. parvus* and *C. serratus* from the English Trias, but differs from them in the shortness of the tooth-like processes. In none of the species do I find such a development of the basis on the inner side."

[No. 6507.]

Sagenodus vabasensis Cope. Plate I, Fig. 7.

Ctenodus vabasensis Cope, 1883, Proc. Phil. Acad. Nat. Sc., p. 110.

Sagenodus vabasensis Woodward, 1891, Cat. Foss. Fishes Brit. Mus., Pt. II, p. 261.

Sagenodus vabasensis Williston, 1899, Kans. Univ. Quart., Series A, p. 176.

"This fine species is represented by an almost perfect tooth. It is allied to the *C. fossatus* Cope, but is wider, and the crests do not radiate so equally, but are chiefly directed in one direction, as in most species of the genus. The *C. gurleianus* and *C. pusillus* are at once distinguished by the small number of crests, while the *C. periprion* and *C. dialophus* have a larger number of crests, and are otherwise different. *C. porrectus* differs less from it, but has only five ½ crests, while *C. vabasensis* has six ½. The ½ represents the small posterior (?) crest, which is double. This, with the next one, is directed slightly posteriorly; the fifth is at right angles to the long axis, and the anterior four extend more or less forwards. They are serrate nearly to their bases, but the teeth are obsolete on their basal halves. The straight part of the internal edge extends as far forwards as the fourth crest, and is continued posteriorly as a short process. No fossæ at ends of crests. Superior face of tooth wide and slightly concave. The anterior part of the first and second crests are broken away, so that it is impossible to say whether they are produced as in *C. porrectus*."

MEASUREMENTS.

"Length to marginal base of second crest	.024[m]
Width at marginal base of second crest	009
Width at fourth crest, inclusive of apex	.015
Width of posterior side	.010
Thickness at base of fifth crest	.005 "

[No. 6510.]

Sagenodus gurleyanus Cope. Plate I, Figs. 8*a*, 8*b*, 8*c*.

Ctenodus gurleyanus Cope, 1877, Proc. Am. Phil. Soc., p. 55.

Sagenodus gurleyanus Woodward, 1891, Cat. Foss. Fishes Brit. Mus., Pt. II, p. 261.

Sagenodus gurleyanus Williston, 1899, Kans. Univ. Quart., Series A, p. 176.

"This species is indicated by a portion of a tooth, which leaves the number of the ridges a matter of uncertainty. On this account its description might have been postponed, but that the distinctness of its characters render it clear that it cannot be placed with any other species. The crown, as in *Ceratodus* (*Sagenodus*) *paucicristatus*, is narrow and rather thick; but three

crests are present, all radiating in the same general direction, the longer close to the inner border. There was not more than one additional crest, or one and a rudiment, and these have probably the same direction as those which are preserved. The crests are sharp, elevated, and coarsely dentate; they are not decurved at the extremity, but cease abruptly with a projecting denticle, beneath which the basis is excavated by a shallow fossa. The inferior face is slightly concave, the internal wall vertical."

MEASUREMENTS.

"Greatest width - - - - - - - .008^{m}
Depth at inner border - - - - - .005 "

[No. 6509.]

Sagenodus pusillus Cope. Plate I, Figs. 9*a*, 9*b*.

Ctenodus pusillus Cope, 1877, Proc. Am. Phil. Soc., p. 191. (Pal. Bull., No. 26.)

Sagenodus pusillus Woodward, 1891, Cat. Foss. Fishes Brit. Mus., Pt. II, p. 261.

Sagenodus pusillus Williston, Kans. Univ. Quart., Series A, p. 176.

"Form narrow, the width of the base about equal to the depth. The coronal portion is narrower than the base, because the inner face is oblique, forming an acute angle with the inferior plane. There are but four crests, of which the two longer are directed in one direction, and the two shorter in another. The interior ones of both pairs form a continuous crest which is convex inwards. The crests are straight, elevated and acute; each one supports two or three denticles, which are rectangular and little elevated. The longer ones project beyond the general outline; the shorter ones are less prominent at the extremities; all are obtuse in the vertical direction. The superior surface is smooth. The inferior is slightly concave in the transverse sense. The tooth on which this species is founded is the smallest yet obtained from the formation (Permian of Illinois). Length, .007^{m}; width, .003^{m}; depth at the inner crest, .003^{m}."

[No. 6508.]

Sagenodus fossatus Cope. Plate I, Figs. 10*a*, 10*b*.

Ctenodus fossatus Cope, 1877, Proc. Am. Phil. Soc., p. 54.

Sagenodus fossatus Woodward, 1891, Cat. Foss. Fishes Brit. Mus., Pt. II, p. 261.

Sagenodus fossatus Williston, 1899, Kans. Univ. Quart., Series A, p. 176.

"Represented by a nearly perfect tooth of a general narrow and vertically thickened form. There are five crests, the largest three extended in one

direction, and the other two in the other. Between the last of the latter and the inner border is a rudiment of another in the form of a rugosity. None of the crests touch each other at their bases. At their extremities they curve rather abruptly downward, and do not project beyond the inferior plane, from which each one is separated by a deep fossa, whose mouth is a notch in its base. The crests are coarsely dentate, there being three or four teeth on each, and the grooves between them are marked by coarse transverse undulating grooves. The inner border is a deep vertical plane; the inferior face is narrow and concave in transverse section."

MEASUREMENTS.

"Total length	.022^{m}
Greatest width	.007
Depth at middle	.006 "

"It differs from the *C. serratus* of Newberry in its narrow form, small number of ridges and the very slight prolongation of their extremities."

[No. 6506.]

Sagenodus heterolophus Cope.

Ctenodus heterolophus Cope, 1883, Proc. Acad. Nat. Sc., Phil., p. 109.

Sagenodus heterolophus Woodward, 1891, Cat. Foss. Fishes Brit. Mus., Pt. II, p. 261.

Sagenodus heterolophus Williston, 1899, Kans. Univ. Quart. Series A, p. 176.

"This species is represented by a single broken tooth, which presents remarkable characters. It had apparently, when perfect, but three crests, which differ greatly in length, diminishing very rapidly from the first or marginal crest.

"The crest just mentioned is not only longer, but *much more* elevated than the others, except at the base, where the second crest is the highest. But while the first rapidly rises, the second retains its elevation, and then descends, forming a convex edge, of which the distal part is obtusely serrate. The proximal part of the first crest is worn by friction with the opposing edge of the opposite jaw into a sharp edge, below which its base is covered by a thin layer of the shining cementum which invests the teeth and sides of the second crest. The amount of this shinning layer is thus more extensive than in any other species of *Ctenodus* known to me. The third crest, judging by its base of continuity with the second, is very small."

MEASUREMENTS.

"Elevation of first crest at middle	.0095^{m}
Elevation of second crest at middle	.0065
Length of a tooth of second crest	.0020 "

[This specimen is missing from the collection.]

Sagenodus paucicristatus Cope. Plate I, Figs. 11*a*, 11*b*.

Ceratodus paucicristatus Cope, 1877, Proc. Am. Phil. Soc., p. 54.

Ptyonodus paucicristatus Cope, 1877, Proc. Am. Phil. Soc., p. 192. (Pal. Bull., No. 26.)

Sagenodus paucicristatus Woodward, 1891, Cat. Foss. Fishes Brit. Mus., Pt. II, p. 261.

Sagenodus paucicristatus Williston, 1899, Kans. Univ. Quart., Series A, p. 175.

"The single tooth representing this species is narrow in the transverse direction, but stout in vertical diameter. But four ridges are present, all of which have a single direction, but the shorter ones are the less oblique to the long axis of the tooth. They all extend into the inner border but become low as they approach it. Distally they are quite prominent, but do not project very far beyond the emarginate border between them. The inner border is plane and vertical, and without ledge; the inferior surface is concave in the transverse direction. The surface of the tooth is minutely and elegantly corrugated."

MEASUREMENTS.

"Length from the base of second rib - - - .017 m
Depth at base of second rib - - - - - .0045 "

[No. 6505.]

Peplorhina arctata Cope.

Peplorhina arctata Cope, 1877, Proc. Am. Phil. Soc., p. 55.

Theromorphous Saurian, Proc. Am. Phil. Soc., 1882, footnote to p. 461. (Pal. Bull., No. 35).

The species was based on an imperfect bone bearing small teeth. From its resemblance to the palatal teeth of *Peplorhina anthracina* the author refers it to that genus with the remark that "this course is open to modification should subsequent investigation require it." Later, in 1882, he remarks in a footnote; "*Peplorhina arctata* Cope from the Illinois Permian is not a *Peplorhina* but a *Theromorphous Saurian*."

The broken specimen originally described certainly has much the appearance of the small teeth which occur in the roof of the mouth of certain of the *Cotylosauria* and may very possibly belong there, but there is present in the collection a complete plate showing no sutural edges. It is certainly a plate from the mouth of a *Crossopterygian* fish, and as the description of the perfect portions of Cope's specimen applies very perfectly to it, it may best be considered under the original name. The applicable portion of the original description is as follows: "The convex surface (of the plate) is thickly

studded with teeth, which are not in contact with each other. Their size increases from one side of the bone to the other, and still more, from one extremity to the other. The crowns are swollen at the nearly sessile base, and contract rapidly to a conical and unsymmetrical apex. One side of the latter is slightly concave below the apex. The surface is shiny and distinctly grooved. Fractured crowns do not display any central cavity."

The present specimen is rather oval, one side showing a perfect convex outline and the other with three straight edges at large angles to each other. The whole plate is convex on the toothed side and concave below. The angulated border is thickened and roughened and the rounded border thin. The surface is covered with teeth, larger in the middle and on the thickened border than on the other edges. The plate is .0158^{m} long and .0114^{m} wide.

[Nos. 6511 (Cope's type) and 6512.]

Cricotus heteroclitus. Plate I, Figs. 12*a*, 12*b*, 12*c*, 12*d*, 13, 14.

Cricotus heteroclitus Cope, 1875, Proc. Phil. Acad. Nat. Sc., p. 405.

Cricotus heteroclitus Cope, 1877, Proc. Am. Phil. Soc., p. 64.

Cricotus discophorus Cope, 1877, Proc. Am. Phil. Soc., p. 186. (Pal. Bull., No. 26.)

Cricotus heteroclitus Cope, 1878, Proc. Am. Phil. Soc., p. 522. (Pal. Bull., No. 29.)

The genus was founded on some intercentra which were regarded as centra of the caudal region; it was not until 1878 that the true nature of the intercentra was made out. With the intercentra were a few other bones doubtfully referred to the same genus. That portion of the original description which is applicable to the bones as intercentra is as follows: "The caudal vertebra (intercentrum) best preserved is stout, discoidal in form, and deeper than wide. It resembles in form that of an herbivorous dinosaurian, but differs otherwise. The articular faces are deeply concave, the posterior most strikingly so; and the middle is occupied by a large foramen, whose diameter is about equal to that of the centrum on each side of it. The lateral borders of the posterior articular face are expanded backwards, and articulate with a bevel of the corresponding edge of the anterior articular extremity. In this way the vertebra combines the mechanical relations of the biconcave with opisthocœlian structures. These neural arches (hæmapophyses) are narrow and directed backwards; their bases are firmly coössified with the centrum." . . . . "On the inferior (superior) surface of the centrum (intercentrum) two shallow pits occupy considerable space. . . . ." It will be noticed that the describer had the intercentrum inverted; this fact was later understood by himself and certain drawings corrected. The structure of the skull and other

portions of the skeleton of the species are described by Cope in the Proc. Am. Phil. Soc., 1878, p. 523 and figured in the same, 1882, Plate II. The synonymy of *C. heteroclitus* and *C. discophorus* was also recognized by Cope in Proc. Am. Phil. Soc., 1878, p. 523.

[No. 6517 (the type specimen), 6518 (type of *C. discophorus*), 6519, and 6520].

Cricotus gibsoni Cope, Plate I, Figs. 15*a*, 15*b*, 15*c*.

Cricotus gibsoni Cope, 1877, Proc. Am. Phil. Soc., p. 185. (Pal. Bull., No. 26.)

Represented in the collection by several vertebræ, all of one form. Cope considered the type specimen as probably from the caudal region. He says, "On this vertebra there is no trace of diapophysis, and the neurapophysis rises from the external side of the superior face. The wall of the neural canal is not preserved, but the inference is that the diameter of the latter is large. This fact and the absence of definite chevron articulations leads me to doubt the caudal position of the vertebra; but the usual marks of the dorsal and cervical vertebrae are totally wanting from it. As in *C. heteroclitus*, the *foramen chordæ dorsalis* is large, its diameter being one third of the total. The articular faces descend steeply into it, that of one extremity more so than the other. The rim of the latter face is beveled outwards, the plane thus produced appearing on the inferior face something like the united faces of the chevron bones.

"The centrum is a little deeper than wide, and the inferior face is truncate so as to give a subquadrate outline. The inferior plane is concave, the concavity being divided by a longitudinal rib. The sides are somewhat concave, with a longitudinal rib at the middle. Diameters of centrum: vertical .010^{m}; transverse .009^{m}; longitudinal .008^{m}. Width of inferior plane .005^{m}; width above, including neurapophyses .008^{m}.

"As compared with *C. heteroclitus* this species differs in the presence of parallel ridges inclosing a median fossa on the inferior side of the centrum. The small size may be considered, but it is uncertain whether the two animals represented by the vertebrae are fully grown."

[Nos. 6521 and 6522.]

Cricotus sp. Plate V, Figs. 13*a*, 13*b*, 14*a*, 14*b*, 15, 16.

There are several phalanges of *Cricotus*. They are much stouter than those of *Clepsydrops;* even in the members of the distal series, where the phalanges are very short, they are still very stout, almost as broad as long. They show a delicate sculpture over the entire surface; the articular surfaces are less well defined than in the reptilian forms. In the middle series they

are longer in proportion than at either end, rather curved, flattened, and with the shaft little less in width than the extremities.

[No 6523.]

Diplocaulus salamandroides Cope. Plate I, Figs, 16*a*, 16*b*, 17*a*, 17*b*. Plate V, Figs. 17*a*, 17*b*, 17*c*, 17*d*.

Diplocaulus salamandroides Cope, 1877, Proc. Am. Phil. Soc., p. 187. (Pal. Bull., No. 26.)

Diplocaulus salamandroides Cope, 1882, Proc. Am. Phil. Soc., p. 451. (Pal. Bull., No. 35.)

Cope's generic description is as follows: "Vertebral centra elongate, contracted medially, and perforated by the foramen chordæ dorsalis; coössified with the neural arch, and supporting transverse processes. Two rib articulations one below the other, generally both at the extremities of the processes, but the inferior sometimes sessile. No neural spines nor diapophysis; the zygapophyses normal and well developed."

Specific description: "The surface of the centrum is smooth and is without grooves. The diapophyses and parapophyses are rather elongate, and are closely approximated one above the other. The superior process issues from the centrum opposite the superior margin of the articular faces. They stand equidistant from the extremities of the centrum, and are directed obliquely backwards. The anterior zygapophyses occupy the same level. The neural spine is a compressed longitudinal ridge; it divides behind, leaving a notch between the posterior zygapophyses."

MEASUREMENTS.

"Diameter of centrum	longitudinal	.0060^{m}
	vertical	.0025
	transverse	.0025
Depth of centrum and neural arch		.0060
Width with transverse processes		.0070
Expanse of posterior zygapophyses		.0050 "

A portion of a small skull was in contact with one of the vertebra. The ramus of the jaw is shallow and stout, the external surface sculptured with inosculating lines. Teeth with cylindrical roots set in shallow alveoli. The crowns elongate, slightly compressed near the apex, and without grooves or lines.

In describing the vertebræ of *D. magnicornis* from Texas (Proc. Am. Phil. Soc., 1882, p. 453) Cope calls attention to the presence of zygosphene and zygantrum in that species; they are also present in the *D. salamandroides*, but are so small as to easily escape notice. The surface of the centrum is stated to be smooth in the Illinois species, this is largely due to weathering, as the more perfect specimens show the same beautiful sculpture as in the Texas forms,

The articulations for the ribs are separate in the cervical region, and become more and more closely united posteriorly. The resemblance between *D. salamandroides* and *D. magnicornis* is very striking, almost the only observable difference being in the size, the latter being from five to six times the size of the former. This statement is limited to the vertebral column, as the skull of the Illinois species is unknown.

In the Proceedings of the Am. Phil. Soc., 1882, p. 452 (Pal. Bull., No. 35), Cope gives a history of the classification of *Diplocaulus* and a summary of the characters of the genus as derived from specimens from the Permian of Texas.

[Nos. 6513, 6514, 6515, and 6516.]

Clepsydrops colletii Cope. Plate II, Figs. 1*a*, 1*b*, 1*c*, 2*a*, 2*b*, 3*a*, 3*b*.

Clepsydrops colletii Cope, 1875, Proc. Phil. Acad. Sc., p. 407.

Clepsydrops colletii Cope, 1877, Proc. Am. Phil. Soc., p. 62.

This genus was based on a series of vertebræ supposed to represent the cervical caudal and dorsal regions. With them were associated other bones, which in all probability did not belong to the same specimen, though they may have belonged to the same species of the genus. The vertebræ were compared with those of the *Cricotus*, or rather with the intercentra of *Cricotus*, as Cope was not entirely sure at the time of the amphibian nature of *Cricotus*. The original description of the vertebræ given by Cope to characterize the genus *Clepsydrops* is as follows: "They are deeply biconcave, the articular cavities being funnel-shaped and continuous, thus perforating the entire length of the centrum. In a dorsal vertebra the cavities communicate by a very small orifice, while in the posterior the median contraction of the canal is less marked. The posterior cavity is more gradually contracted than the anterior; in the latter the excavation is, in most of the vertebræ, but slight (except beneath the floor of the neural arch), until it falls rather abruptly into the axial perforation. In an (?) anterior dorsal it is as widely excavated at the border as the posterior funnel. Another peculiarity s the abscence of the processes of the centrum; and a small capitular articulation is seen sessile on the border of the cup of two of the dorsals.

"The axis has a singular form, owing to the tubular perforation which continues the posterior excavation to the anterior face of the centrum. There are three articular faces, a larger subround inferior and two smaller superior, which border the neural canal in front and below and are separated from each other and the inferior face by the perforation in question. The anterior face slopes obliquely backwards and downwards, and is convex in transverse section. There is no facet for the free hypapophysis of the odontoid, but it appears that the inferior articular face was applied exclusively to the centrum of the atlas, as in *Sphenodon*. But the axis differs from that of the

latter genus in the abscence of a coössified odontoid process. Either that element is entirely wanting or it consists of two pieces, interrupted in the middle by the notochordal foramen, and in correspondence with superior articular facets. There is no true hypapophysis of the axis, and the only indication of lateral processes is a small articular facet on each side on the lower part of the rim of the posterior funnel. These may have been related to rudimental cervical ribs. The neural arch is broken off.

The dorsal vertebræ have their sides somewhat contracted; in one specimen the inferior face is rounded, in another, which I suppose to belong to a different part of the column, it is longitudinally acute. In this and another dorsal, where the parts are exposed, the floor of the neural canal is interrupted by a deep fissure, which has a triangular shape with apex downward when seen in profile. This is due to the fact that the opposite halves of the centrum are united by the circumferences of the articular cups, which have in profile an X shape. The diapophysis does not project far beyond the base of the neural arch and is compressed. The caudals are elongate, and resemble, in the forms of the centrum and neural arch, those of *Lælaps*. The neural spines are not preserved, but if present were directed well backwards, bearing the posterior zygapophyses, since the arch stands only on the anterior three-fifths of the centrum. Chevron facets are not distinct, but two emarginations on the rim of the posterior face of one of the vertebræ indicate their existence. In other centra even these notches are wanting. The tail was evidently tapering. There is no evidence of the transverse fissures seen in *Sphenodon* and many *Lacertilia*, nor are there any diapophyses on the caudal vertebræ preserved.

Specific characters: "There is a shallow fossa in the entering angle between the superior and inferior articular facets of the front of the axis, and the centrum of the same is obtusely keeled below. The border of the anterior face of the dorsal vertebræ with keeled centrum is undulate. The obtuse inferior face of another dorsal is rugulose, and the edge of the face is not undulate. The inferior faces of the two caudals are marked with fine parallel grooves, while in another caudal and the (?) sacrals the same is smooth. There are some longitudinal ridges on the upper side of the larger caudal."

MEASUREMENTS.

"Length of centrum of axis	.006^{m}
Width do. at middle behind	.008
Depth do. (oblique)	.010
Length centrum of sharp keeled dorsal	.014
Depth do. behind	.012
Width do. behind	.012
Length centrum rounded dorsal	.012
Depth do. behind	.011
Width do. behind	.010
Width neural canal do.	.004

Length centrum larger caudal	.014[m]
Width do.	.008
Depth do.	.008
Length smaller caudal	.010
Depth centrum do.	.007
Width do.	.007 "

[Nos. 6530 (type specimen), 6531, and 6578.]

Clepsydrops pedunculatus Cope. Plate II, Figs. 4*a*, 4*b*, 4*c*, 4*d*; Figs. 5*a*, 5*b*, 5*c*, 5*d*.

Clepsydrops pedunculatus Cope, 1877, Proc. Am. Phil. Soc., p. 63.

This genus was established on two vertebræ, a third cervical, and an anterior caudal, regarded by Cope as a dorsal.

"Both differ from corresponding vertebræ of *C. colletti* and *C. lateralis* (this is evidently a slip on the part of the describer; there is no *C. lateralis; C. vinslovii* is evidently referred to, as it was the only other species of the genus described at this date) in having elongate diapophyses for the attachment of the ribs. These are present in the other species, but are either very short, or sessile. The third cervical has a broad reverted anterior lip-like margin of the anterior articular face, which resembles the corresponding part in *C. lateralis* (*vinslovii*) in not being produced below. The median line is keeled, and there is a shallow longitudinal groove on the upper part of the sides. The posterior articular face is regularly funnel shaped. The diapophyses are very stout, and are directed a little downwards and strongly backwards. The articular faces are single, look downwards and outwards, and are wide above, and narrow below. The base of the neural canal is deeply incised, as in the other species."

MEASUREMENTS.

" Diameter of centrum	antero-posterior	.015 [m]
	transverse	.0125
	vertical	.012
Length of diapophysis above		.009
Diameter of diapophysis	vertical	.008
	antero-posterior	.005 "

In the description of the supposed dorsal attention is called to the long and slender diapophysis; it is evident that this is not a diapophysis, but an anchylosed rib with the distal broken portion inclined forward, as is characteristic of the anterior caudal ribs of the *Rhyncocephalia*. Speaking of other portions of the vertebra, the describer says: "There is no recurved rim of the articular extremities, but the surface does not pass regularly into the foramen chordæ dorsalis, but by an abrupt descent at its mouth. The

sides of the centrum are concave, and the inferior portion forms a prominent rounded rib."

MEASUREMENTS.

" Diameter of centrum	antero-posterior	.016[m]
	transverse	.015
	vertical	.016 "

[Nos. 6534 (type specimen) and 6535.]

Clepsydrops vinslovii Cope. Plate II, Figs. *7a*, *7b*, *7c*, *7d*.

Clepsydrops vinslovii Cope, 1877, Proc. Am. Phil. Soc., p. 62.

This species was based on a single cervical vertebra with which others were uncertainly identified. The specific characters given are as follows: "The inferior median line is a keel; some distance above it, the sides of the centrum are full, rising in a longitudinal angle. There is no constriction or fossa below the diapophysis as in *C. colletti*. The latter is anterior in position, is vertically compressed, and is curved forward for a short distance below. The posterior articular face is regularly funnel-shaped from the margin; the anterior face has a broad recurved lip. This passes around the inferior margin, which is not projected forwards as in *C. colletti*. The zygapophyses are well developed, and stand close together. The neural spine is compressed, and the basal portion points somewhat forwards."

MEASUREMENTS.

" Length of centrum		.011[m]
Diameter of posterior articular face	vertical	.009
	transverse	.009
Vertical diameter of diapophysis		.006
Expanse of posterior zygapophysis		.009
Antero-posterior diameter of base of neural spine		.005
Transverse diameter of neural arch		.006 "

[Nos. 6532 (type specimen) and 6533.]

Lysorophus tricarinatus Cope. Plate II, Figs. *12a*, *12b*, *12c*.

Lysorophus tricarinatus Cope, 1877, Proc. Am. Phil. Soc., p. 187. (Pal. Bull., No. 26.)

The type specimens consist of two vertebræ and a portion of a third. The generic characters given by Cope are as follows: "Vertebræ amphicœlian, perforated by the foramen chordæ dorsalis. Neural arch freely articulated to the centrum. Floor of neural canal deeply excavated. No processes or costal articulations on the centrum, which is excavated by longitudinal fossæ. Centrum not shortened." Specific characters: "Two centra and a portion of a third represent this species. The former are a little longer than wide and a little depressed. The facet for the neural arch is an elongate plane truncating the border of the fossa of the neural canal on each side,

for one half to three fifths the length of the centrum. Two deep longitudinal fossæ extend on each side of a median rib of the inferior face; and they are separated above by a narrower rib from another longitudinal fossa which is below the base of the neural arch.

MEASUREMENTS.

" Diameter of centrum	longitudinal	.0055^{m}
	vertical	.0038
	transverse	.0040
Length of facet for neurapophysis		.0035
Width of neural canal		.0020 "

This form differs very decidedly from any other in the collection in the prominence of the keel and the lateral ridges; they, or rather the fossæ between them, are developed to an extent that almost destroys the centrum, leaving but a very slender tube surrounding the notochord. A few centra of larger size show strongly developed keels and free neural arches, but much stouter proportions.

[Nos. 6526 (the type specimen; it is badly broken), 6527, and 6528.]

Archæobelus vellicatus Cope. Plate III, Fig. 1.

"*Species No. 4*" Cope, 1877, Proc. Am. Phil. Soc., p. 56.

Archæobelus vellicatus Cope, 1877, Proc. Am. Phil. Soc., p. 192. (Pal. Bull., No. 26.)

This genus is represented by teeth alone. In his discussion of the form Cope says, in the earlier paper, "there is nothing to prevent their (the teeth) reference to the *Lacertilia*." The generic description is as follows: "The form is conical, and the surface is not grooved nor furnished with prominent ridges. The interior is hollow, and the walls are composed of a few concentric layers without external enamel or cementum. The solid base to which it is attached is shallow, presenting smooth surface on the opposite side, which is deeply impressed by a longitudinal groove at one end." The specific description is given in the earlier paper: "The crown is conic, subround in section, and curved backward. There are no cutting edges, and the base is a little flattened in front and behind. On each of the faces thus formed, there is an open, shallow groove, sometimes obsolete. There are no other grooves or sculpture on the teeth. . . . . One of the specimens displays an extensive pulp cavity."

MEASUREMENTS.

	First specimen	First specimen	Second specimen
" Diameter of base	.004^{m} long	.008^{m} short	.005^{m}
		First specimen	Second specimen
Length of crown		.010^{m}	.015^{m} "

There are several specimens of the isolated teeth described by Cope in the collection, but in addition a considerable portion of a maxillary bone which

shows many points of interest. In all the single teeth, as described by Cope, they are attached to a portion of the jaw and unaccompanied by any other teeth, but there is posterior to the tooth a cavity which, as shown by the more perfect jaw, accommodated a second tooth larger even than the first. In the fragment of the jaw there are, first, three quite small teeth, and then, supported by a swollen portion of the rim, there are two very large canine teeth ; posterior to these, three teeth about equal in size to those anterior to the canines, and then five smaller ones. As both ends of the piece are incomplete, it is certain that there were more teeth than here recorded. Several differences from *Clepsydrops* and *Dimetrodon* are apparent: first, the anchylosis of the teeth to the jaw, instead of being inserted in well defined alveoli; second, the presence of two enlarged canines instead of one, and third, the possible absence of the diastema anterior to the canines; for in the *Dimetrodon* the anterior teeth of the maxillary decrease to small size immediately and the notch of the diastema begins just anterior to the canine and below the external nares, but here, though the anterior tooth is almost below the nares, there is no sign of the beginning of the notch, if any existed. The teeth are all more or less rounded in section and show no sign of a cutting edge. In general appearance the jaw is much like that of the Pelycosaurians; *i. e.*, with a thin outer wall and a heavy shelf-like dentigerous edge.

Associated with the fragments of the upper jaws are several portions of the lower jaws showing the symphasial region. Some of the anterior teeth, about the third and fourth, seem to have been slightly larger than the others, but as such a small part is preserved it is impossible to say definitely. These fragments may have belonged to the genus *Clepsydrops*, and, indeed, the fragments of the upper jaws also.

[Nos. 6524 and 6525.]

UNNAMED SPECIMENS.

Besides the specimens named and described by Cope there are present in the collection many isolated bones from different parts of the skeleton which cannot be identified with certainty as belonging to any of the forms described; that they belong to some of them is practically certain. The fact that the bones are nearly always found isolated and generally in a fragmentary condition prevents any attempt at a restoration of the skeleton, but their resemblance to corresponding bones from the Texas deposits makes it probable that the animals from the two regions did not differ materially in form. One fact is noticeable, the

absence of animals of any great size as compared with the Texas forms.

Skull.— The skull is represented by two nearly perfect maxillaries, apparently the bones from the two sides of the same specimen, and several fragments showing the occipital condyles.

The premaxillaries are similar to those of *Dimetrodon* and of *Empedias* as figured by Cope. The external surface is pitted, and there was evidently a large opening of the external nares. The teeth do not show any great disparity in size nor are they chisel-shaped; there is no evidence of the presence of a diastema as in the *Pelycosauria* in general, but this may be due to the imperfection of the bone. Plate III, Figs. 2, *a* and *b*. [No. 6536.]

The occipital condyles are well rounded, hemispherical in outline, the upper edge being slightly concave, and marked by a pit near the upper edge. [No. 6537.]

Vertebræ.— There are a great many vertebræ, either isolated specimens or small lots belonging together; the majority evidently belong to one or the other of the three species of *Clepsydrops* described. There are two lots that seem different from the others.

Two vertebræ very much larger than the others apparently belong to the lumbar or posterior dorsal region. They are characterized by the breadth of the centrum as compared by its height. The lower surface is marked by a rounded but prominent keel. One shows measurements corresponding very closely with those given by Cope for *C. natalis* from Texas. It is very possible that they represent this species. [No. 6538.]

A second set of vertebræ resemble in large measure those of *Lysorhophus tricarinatus* in the free articulation of the neural arch to the centrum and the general form of the centrum; they differ, however, in the absence of the strongly marked keels and the deeply incised fossæ between them. They vary greatly in size, some being as large as those of *L. tricarinatus* and others three or four times as large. If it were not for the presence of vertebræ of different size they might be regarded as dorsals of the described species. As it is, they seem to indicate a possible new species.

MEASUREMENTS.

"Length of a centrum	.011[m]
Breadth of a centrum	.011
Length of a second centrum	.007
Breadth of a second centrum	.006 "

Plate II, Fig. 13, *a*, *b*, and *c*. [No. 6529.]

Scapula.— There are many incomplete scapulæ in the collection. They are all of small size, but resemble in form those figured by Cope (Proc. Am.

Phil. Soc., Aug. 1884, and Proc. Am. Assoc. and Sc., 1884, Vol. XXXIII), and Case (Trans. Am. Phil. Soc., 1899, Vol. XX.) One specimen shows the proximal end with articular cavity for the humerus formed by the scapula and coracoid. The scapula is perforated by a foramen just above the articular face. Plate III, Fig. 3. [No. 6540.]

Humeri.—There are four types of humerus. One, the largest, is relatively much shorter and stouter than the others, and is remarkable for the strong articular faces and the generally robust character. The proximal end is marked by prominent rugosities and the deltoid crest is laterally expanded, much more so than in the other forms, and very rough. Length .14^{m}; width of the head at the deltoid ridge .057^{m}. Plate III, Fig. 4, *a*, *b*. [No. 6541.

The second form has a much longer shaft than the first, and at all points shows a greater elegance of form at the expense of strength, but the extremities are as well formed and the articulate surfaces as distinct. This probably belongs to one of the described forms of *Clepsydrops* from Illinois, probably the largest, *C. pedunculatus*. A smaller form of the same type is represented by the distal end of another humerus, which is perfectly preserved. The entepicondylar foramen is large and elongate, the ectepicondylar foramen is represented by a notch, as in all the *Pelycosauria;* the head for the proximal end of the radius is prominent, almost hemispherical and well formed, it is continuous with the articular surface for the ulna. Height of fragment .066^{m}, width at deltoid ridge .030^{m}. Plate III, Fig: 5, *a*, *b*, *c*, and Fig. 6. [Nos. 6542, 6543, and 6575.]

The third type is represented by the distal end of a very small form similar in many respects to the foregoing, but with the internal process rounded and truncated and the entepicondylar foramen missing. The form is very small and the shaft of the bone was slender, but the distal extremity shows a strong development. The process forming the ectepicondylar notch is prominent, and the portion of the distal extremity on either side of the articular surface extended below the surface instead of lying in a line with it or not reaching so far. This form may be the same as the "No. 6" mentioned by Cope in his first contribution to the fauna of the Texas Permian, but as it was not described nor figured, it is impossible to say definitely. The humerus "No. 6" is regared by Cope as belonging to a possibly fossorial animal, this may be true of the present form, but there is no vertabræ in the collection which could go with such a type. Plate III, Fig. 7. [No. 6544.]

The fourth and last type differs very considerably from the others. The ends are concave, as if they had been cartilaginous in life, and there are no articular surfaces distinguished. The extremities are at right angles to each other, and there is a small deltoid process, continuous with the proximal end. The entepicondylar foramen is present, but there is no trace of an

ectepicondylar notch. Length .038^{m}, width proximal end .0105^{m}, distal end .0205^{m}. Plate III, Fig. 8, *a*, *b*, *c*, *d*. [No. 6545.]

Ulnæ.—There are two types of ulna distinguished by the size only. One is nearly as large as the ulna of *Dimetrodon incisivus* and quite similar to it; the proximal end only is preserved; the other is smaller, represented by the proximal end also, and probably belongs to one of the smaller species of *Clepsydrops*. Plate III, Fig. 9. [Nos. 6546 and 6547.]

Femoræ.—The femora are mostly of the same type, but show considerable variation in size. They all have the distal articular surfaces upon the inner or lower face of the distal end, showing that the leg was habitually flexed and the animal progressed, probably, with the belly on or near the ground, in the manner of the alligator. One of the medium sized forms is figured (No. 6548). Length of one specimen, .077^{m}; a larger specimen, .107^{m}. Plate IV, Fig. 1, *a* and *b*. [Nos. 6548, 6549, 6550, 6551, 6552, and 6553.]

The distal ends of two very small femora are present; they lack well-developed articular surfaces, though the contour of the extremity is the same as in the larger specimens. It seems probable that they are immature forms. [No. 6552.]

Tibia.—There is one complete tibia, somewhat crushed, and the proximal end of another. The whole bone is larger at the proximal than at the distal extremity, and is considerably curved. The shaft is more or less flattened. The proximal end has two faces, which are distinct, or nearly so; they are oblong and lie with their long axes nearly at right angles to each other. The anterior extremity of one anticular face forms the upper portion of the cnemial crest. Measurements: length, .049^{m}. Plate IV, Fig. 2, *a* and *b*. [No. 6555.]

Fibula.—What appears to be a fibula is .053^{m} long. It is a slender bone, expanded at the extremities and quite strongly curved. Plate IV, Fig. 3. [No. 6554.]

Ilia.—There are two types of ilia of about the same size. Each presents two articular faces at the distal portion for articulation with the ischium and pubis and a rather deeper articular portion of the acetabulum; at the upper portion of the acetabulum there is a prominent overhanging process. The two forms differ principally in the anterior process of the ilium with which it is attached to the sacral vertebræ. In one form it extends almost straight forward (No. 6556) and in the other (No. 6557) it is curved and the anterior end is somewhat lower than the posterior. The inner side of each presents strong longitudinal ridges and there does not seem to be any articular facet for the vertebræ. In an incomplete fragment, in which the ischium and ilium are in contact, the acetabulum is seen to be quite deep. Plate IV, Figs. 4 and 5. [Nos. 6556, 6557, and 6558.]

Footbones.—There is a large series of footbones, the position of most of which it is impossible to determine. They are all well formed, with good articular surfaces, showing that the carpus and tarsus was fairly strong and well knit. Some of the more common bones of indefinite position are shown in Plate V, Figs. 18, *a* and *b*; 19, *a* and *b*; 20, *a* and *b*. [No. 6559.]

Astragali.—There seem to be two forms of astragalus. The first is much the more slender and smaller. There are two distinct facets for articulation with the calcaneum; the upper of these is the largest and is separated from the lower by a notch which, in combination with a similar notch separating the two articular faces on the calcaneum, forms a foramen between the bones. On the opposite side of the bone there is a large face set at an angle with the body of the bone, apparently for the tibia. The lower rim of the bone between the described regions has a narrow face for the bones of the tarsus. This ilium was ascribed by Cope to *clepsydrops colletii*. The form of the bone is shown in Plate IV, Fig. 7, *a*, *b*, *c*, *d*. [No. 6560.]

The second type is of stouter proportions than the first and larger; the articular faces are arranged much the same, but are broader and the face for the distal end of the tibia is more sharply divided into faces meeting at a considerable angle. Plate IV, Fig. 8, *a* and *b*. [No. 6561.]

Neither of these forms corresponds with the figure of the astragalus of *Clepsydrops leptocephalus*, published by Cope (Proc. Am. Phil. Soc., Aug. 1884; Am. Assoc. Ad. Sc. Vol. XXXIII, 1884), nor to an astragalus of *Pariotichus incisivus* in the collection of the Walker Museum.

The strong angulation of the tibial face is described by Cope as belonging to the genus *Dimetrodon*, so that it is possible that the larger astragalus in the Illinois material may represent that genus.

Calcanea.—The calcanea are of the type characteristic of most of the Permian reptiles from America. Large, subround disks of no great thickness; the side toward the astragalus presents two facets separated by a notch; above and below are facets for the fibula (?) and the tarsal bones. Plate IV, Fig. 9, *a* and *b*. [No. 6562.]

Metacarpals and Tarsals.—The metacarpals and tarsals are long and slender, with well developed articular faces. Plate V, Figs. 1 and 2. [No. 6563.]

Phalanges.—The phalanges show the same well developed form as the preceding row, even to the terminal series. The terminal series are slender, pointed, and curved, and evidently supported strong claws. Plate V, Figs. 3–9, and 10, *a* and *b*. [Nos. 6564 and 6565.]

Among the specimens that cannot be referred with certainty to any form are the following:

Teeth.—There are several isolated teeth or portions of jaws with teeth attached, which cannot be assigned to any of the described forms. It is probable that if more complete material were at hand they would be found to belong to forms already described, either from Illinois or Texas.

"*Species one*" Cope, 1877, Proc. Am. Phil. Soc., p. 56.

This is an incomplete maxillary with six broken teeth. "They stand in close juxtaposition and are of equal size. The basal half or more of the crown displays the character of deep inflections or grooves. These teeth belong to some sauroid fish or batrachian." Plate V, Fig. 12. [No. 6566.]

"*Species two*" Cope, 1877, Proc. Am. Phil. Soc., p. 56.

A fragment of a mandibular ramus with four teeth. "The anterior of these is larger and is separated from the others by an edentulous space. Their crowns are rather elongate and are compressed, having cutting edges fore and aft. Both edges contract to the apex, but the anterior the more so. There are a few shallow grooves at the base, but they appear to be superficial only." As remarked by Cope, it is impossible to tell whether they belong to an amphibian or a reptile. Plate V, Fig. 11. [No. 6567.]

"*Species three*" Cope, 1877, Proc. Am. Phil. Soc., p. 56.

"Two stout, slightly flattened, conic teeth, without cutting edges, represent this species. They are anchylosed to a very thin plate of bone, a part of which adheres to each. The base is oblique, expanding more in one direction than in another. The greater part of the crown is marked by closely placed parallel grooves, which are more numerous than in the species No. 1. They are larger than those of No. 2, measuring .004^{m} in diameter at the base. They may belong to any one of a number of known genera of batrachia or sauroid fishes." [No. 6568.]

Besides these, there are two teeth that seem to indicate forms not otherwise represented in the collection. The first is rather conical and recurved, the upper end truncate, but the inner side shows a concave region of wear against the opposed tooth. This would seem to show that it is either an incisor or one of the lateral teeth, probably the first, of some member of the *Diadectidæ*. Plate V, Fig. 23, *a* and *b*. [No. 6569.]

The second is a very stout, conical tooth, much larger than any other in the collection. Its surface is marked with deep, irregularly arranged grooves. Plate V, Fig. 24. [No. 6570.]

A lower jaw, nearly complete, resembles very closely that of *Pariotichus* from Texas. The articular region is complete and shows a well formed face and a prominent spur extending posterior to the cotylus. Fragments of other jaws show the same feature. The outer side is marked by strong reticulate sculpture, which at the posterior part seems to radiate from a point on

the lower margin about an inch from the posterior end; on the anterior portions the lines are straighter and lie parallel to the length of the jaw. The teeth were very small. A small fragment attached to the inner side of it is covered with many minute teeth; this may be a portion of the dentition of the upper jaw. [No. 6571.]

A collection of fragments showing a fine sculpture on one side are probably portions of the skull of *Diplocaulus*. Among these are imperfect plates with a much coarser sculpture, which are probably abdominal scales. [No. 6572.]

There are two pubes nearly complete; they may belong to *Cricotus*. There is a considerable portion of the acetabular face present. This portion of the bone is thickened, and besides supporting the acetabular face has a broad face for the ilium. Just below these faces the bone is perforated by a foramen. Beneath the foramen is the symphasial region, which is remarkably broad and thick in proportion to the rest of the bone. In general the outline of the bone was subround, but the lower posterior portion was very thin, and portions have been broken away in both specimens. On the upper margin, posterior to the facet for the ilium, there is a slender tubercle which bears an articular facet; in one specimen this is isolated and in the other it is confluent with a broad facet on the thickened posterior border. Plate IV. Figs. 6, *a* and *b*. [No. 6573.]

There are a few coprolites of small size. They show spiral markings indicative of a spiral vale in the stomach of the form to which they belonged. [No. 6574.]

EXPLANATION OF PLATES.

PLATE I.

FIG. 1. *Janassa linguæformis*. Twice nat size. *a*) from below, *b*) from above, *c*) from the side.

FIG. 2. *Janassa gurleyna*. Twice nat. size. *a*) from below, *b*) from above, *c*) from the side.

FIG. 3. *Pleuracanthus quadraseriatus*. *a*) from the side, *b*) from the front.

FIG. 4. *P. gracilis*.

FIG. 5. *P. compressus*. *a*, *b*, *c*, and *d*.

FIG. 6. *Sagenodus vinslovii*. *a*) from below, *b*) from above.

FIG. 7. *S. vabasensis*.

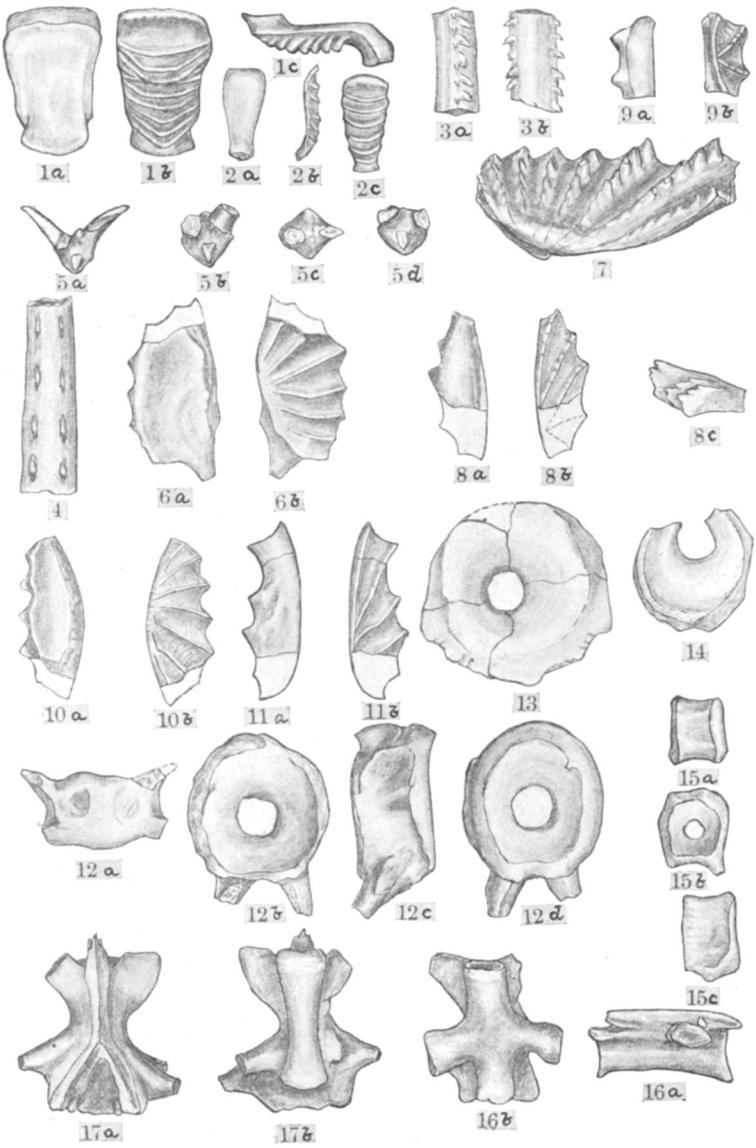
FIG. 8. *S. gurleyanus*. *a*) from below, *b*) from above, *c*) from the side.

FIG. 9. *S. pusillus*. *a*) from below, *b*) from above.

FIG. 10. *S. fossatus*. *a*) from below, *b*) from above.

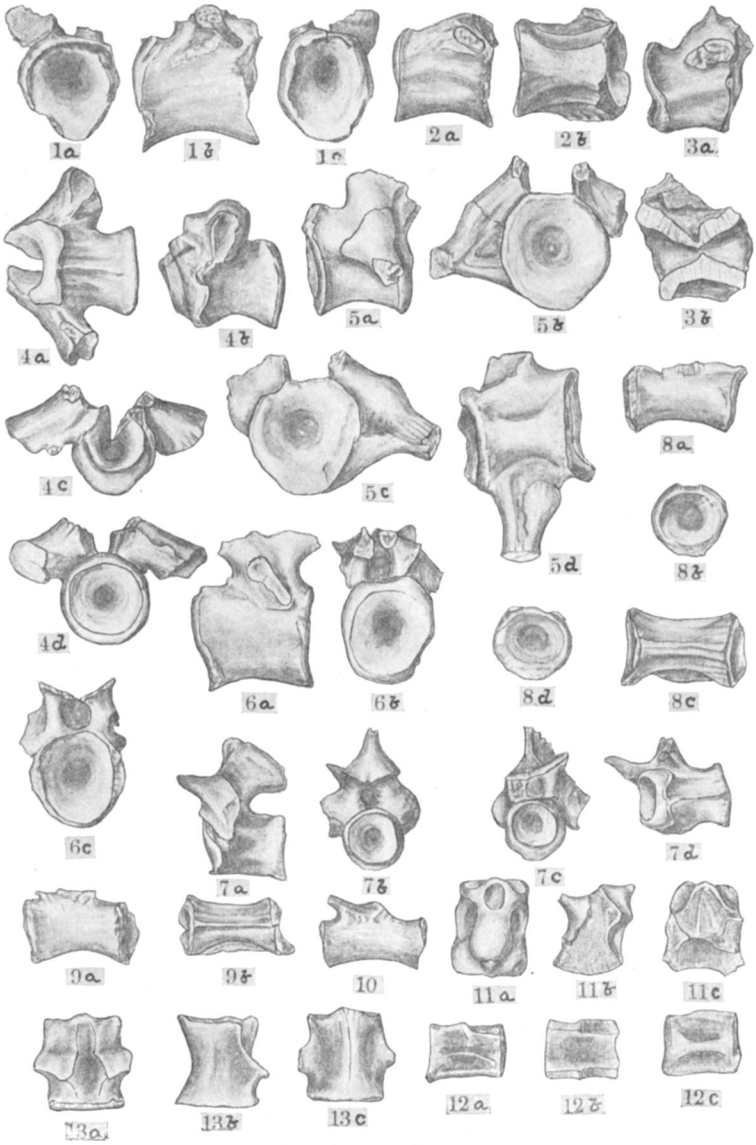
FIG. 11. *S. paucicristatus*. *a*) from below, *b*) from above.

JOUR. GEOL., Vol. VIII, No. 8 Plate I



Permian vertebrates.

JOUR. GEOL., Vol. VIII, No. 8 Plate II



Permian vertebrates.

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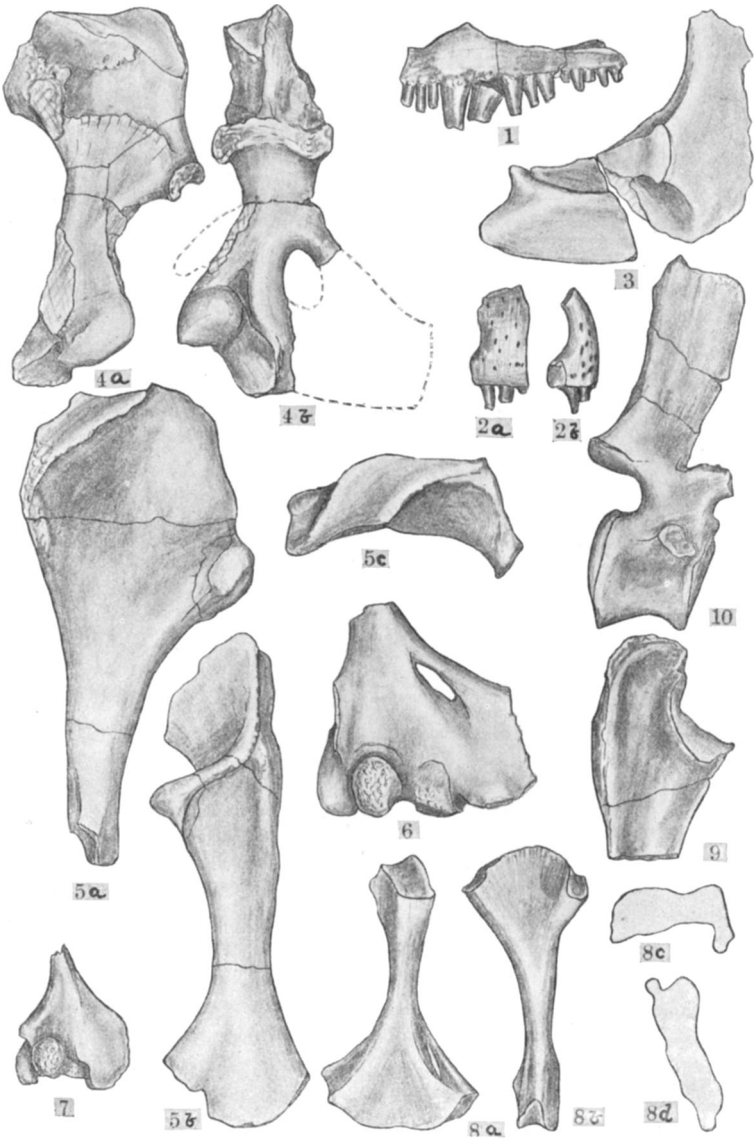

Permian vertebrates.

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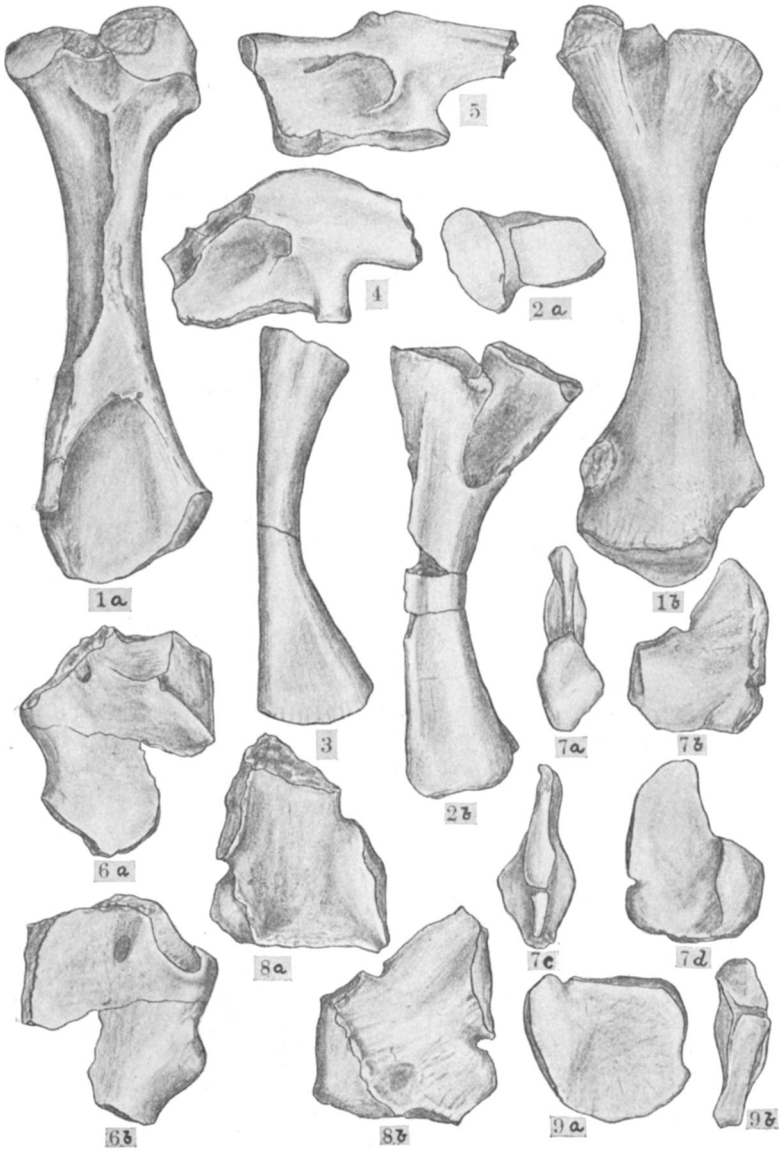

Permian vertebrates.

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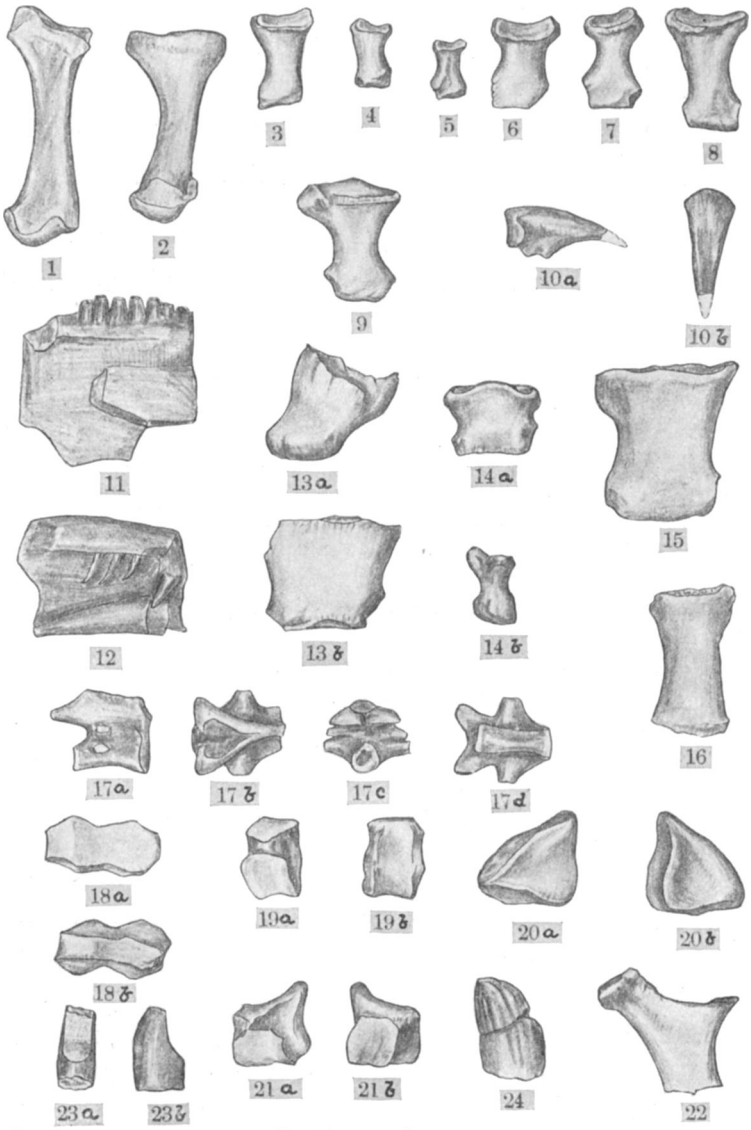

Permian vertebrates.

FIG. 12. *Cricotus heteroclitus.* Intercentrum. *a*) from above, *b*) from before, *c*) from the side, *d*) from below.

FIG. 13. *C. heteroclitus.* Intercentrum.

FIG. 14. *C. heteroclitus.* Intercentrum.

FIG. 15. *C. gibsonii.* Intercentrum.

FIG. 16. *Diplocaulus salamandroides* Dorsal vertebra. *a*) from the side, *b*) from below. Twice nat. size.

FIG. 17. *D. salamandroides.* Dorsal vertebra. *a*) from above, *b*) from below. Twice nat. size.

PLATE II.

FIG. 1. *Clepsydrops colletii.* Dorsal vertebra. *a*) anterior, *b*) lateral, *c*) posterior.

FIG. 2. *C. colletii.* Dorsal vertebra. *a*) lateral, *b*) inferior.

FIG. 3. *C. colletii.* Dorsal vertebra. *a*) lateral, *b*) showing vertebra divided on median line.

FIG. 4. (?) *C. colletii.* *a*) inferior, *b*) lateral, *c*) anterior, *d*) posterior.

FIG. 5. *C. pedunculatus.* Anterior caudal. *a*) lateral, *b*) anterior, *c*) posterior, *d*) inferior.

FIG. 6. *C. sp.* Dorsal vertebra. *a*) lateral, *b*) posterior, *c*) anterior.

FIG. 7. *C. vinslovii.* Dorsal vertebræ. *a*) lateral, *b*) posterior, *c*) anterior, *d*) inferior.

FIG. 8. *C. sp.* Caudal vertebra. *a*) lateral, *b*) anterior, *c*) inferior, *d*) posterior.

FIG. 9. *C. sp.* Caudal vertebra. *a*) lateral, *b*) inferior.

FIG. 10. *C. sp.* Caudal verebra, lateral.

FIG. 11. *C. sp.* Axis. *a*) anterior, *b*) lateral, *c*) inferior.

FIG. 12. *Lysorhophus tricarinatus.* Dorsal (?) vertebræ. *a*) from the side, *b*) from above, *c*) from below.

FIG. 13. *L. sp.* Dorsal (?) vertebræ. *a*) from above, *b*) from the side, *c*) from below.

PLATE III.

FIG. 1. *Archeobolus vellicatus.* Maxillary.

FIG. 2. Premaxillary. *a*) from before, *b*) from the side.

FIG. 3. Scapula and Coracoid.

FIG. 4. Humerus. × ½. *a*) lateral view, *b*) posterior view.

FIG. 5. Humerus. *a*) anterior, *b*) proximal end, *c*) lateral, half nat. size.

FIG. 6. Humerus. Distal end of same form as 5.

FIG. 7. Humerus. Distal end.

FIG. 8. Humerus. *a*) anterior view, *b*) lateral, *c*) and *d*) outlines of the proximal and distal faces in natural position.

FIG. 9. Proximal end of Ulna.

PLATE IV.

FIG. 1. Femur. *a*) anterior, *b*) posterior.

FIG. 2. Tibia. *a*) proximal end, *b*) anterior view.

FIG. 3. Fibula.

FIG. 4. Ilium.

FIG. 5. Another type of ilium.

FIG. 6. Pubis. *a*) inner view, *b*) outer view.

FIG. 7. Astragalus of *Clepsydrops sp.* *a*) tibial face, *b*) anterior (?) face, *c*) calcaneal face, *d*) posterior (?) face.

FIG. 8. Astragalus of *Clepsydrops sp.* *a*) anterior (?) face, *b*) posterior (?) face.

FIG. 9. Calcaneum. *b*) astragalus face.

PLATE V.

FIGS. 1 and 2. Metacarpals of *Clepsydrops.*

FIGS. 3–9. Phalanges of *Clepsydrops.*

FIG. 10. Terminal phalanx of *C.* *a*) lateral, *b*) superior views.

FIG. 11. "Species one."

FIG. 12. "Species two."

FIG. 13. Phalanges of *Cricotus.* *a*) lateral, *b*) anterior views.

FIG. 14. Phalanges of *Cricotus.* *a*) anterior, *b*) lateral views.

FIGS. 15 and 16. Phalanges of *Cricotus.*

FIG. 17. *Diplocaulus salamandroides.* Dorsal vertebra. *a*) lateral, *b*) superior, *c*) terminal, *d*) inferior views.

FIGS 18–21. Carpal bones.

FIG. 22. Proximal end of a rib

FIG. 23. Incisor tooth. *a*) anterior view, *b*) lateral.

FIG. 24. Tooth.

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